The need to make life cycle analysis unbiased and representative outside the original context: set-up of two cases studies

THE NEED TO MAKE LIFE CYCLE ANALYSIS UNBIASED AND REPRESENTATIVE OUTSIDE THE ORIGINAL CONTEXT: SET-UP OF TWO CASE STUDIES

Enrica Vesce[1,*], Maria Beatrice Pairotti[2], Francesca Giordana[3]

[1]Dipartimento di Scienze Merceologiche, Università degli Studi di Torino
Corso Unione Sovietica 218 bis, Torino, +39 0116705711 vesce@econ.unito.it.it
[2] Dipartimento di Scienze Merceologiche, Università degli Studi di Torino
Corso Unione Sovietica 218 bis, Torino, +39 0116705711 pairotti@econ.unito.it
[3] Trainee in Dipartimento di Scienze Merceologiche, Università degli Studi di Torino
+39 349 4661225 francesca.giordana@live.it

Abstract

This article deals with the important issue of having consistent *average datasets* available for Life Cycle Analysis. The question about whether or not a LCA on a specific case study could be sufficiently representative of other realities is examined, and solutions and analysis here suggested by authors go into deep about the essential role played by national and international databases. As a matter of fact, databases make a consistent amount of "*secondary data*" and information, collected in a specific geographic area, available to conduct LCA studies able of depicting the considered reality with unbiased results and considerations. These sets of information are useful both for "*company specific LCA*" intended to assess a specific production system, and for "*industry average LCA*" which aim is assessing a medium manufactor system in a specific geographic area.

Hence, this article has the aim of showing a short cut of main technical problems which still need to be set down, going through two case studies which played the important role of leading the authors in facing these issues. The research cases concern environmental impacts assessment of food farming products, and have the objective of building a new innovative and multidisciplinar index for environmental, social and economic assessment, and of misuring the correlation between environmental impacts and social dynamics, too.

Thanks to the research work, it has been underlined the need for our scientific society of making *Regional LCAs* in the sense of *Italian LCA*, which, to be unbiased, must be based on Italian collected data consistently averaged.

Keywords: average dataset, regional LCA, life cycle inventory database

Introduction

As known, the LCA methodology was born as instrument able to assess the energetic and environmental impacts of a specific product or a manufactor process, during its whole life cycle (Guinée et al., 2011).

The results can be used to inform about the "environmental quality" of a product, and to compare different products or processes in order to determine which one holds the higher efficiency rate, from

energetic and environmental points of view. Thanks to these goals, LCA spread worldwide in last decades, and lead researchers and companies to elaborations and even unexpected results.

Many times the International scientific community had to wonder whether or not a LCA could be representative and unbiased even outside the original context. Nowadays LCA role in scientific research and throught the path of sustainable progress has been agreed; as a consequence the doubt about the feasibility of making an instrument, born to be representative of a unique context, capable of depicting even outside realities showed up. This arrangement would be significant in both following situations: the comparison between two "*company specific LCAs*" (that is the comparison between two products or processes) and the construction of a "*industry average LCA*" representative of a whole sector.

In particolar the issue can be synthesized as follows: is it possible to build a consistent "*industry average LCA*"? Is it possible to make an LCA study an unbiased set of information capable of representing a specific manufactor sector in a established geographic area? If possible, are there any particular aspects to pay attention to for arrangements?

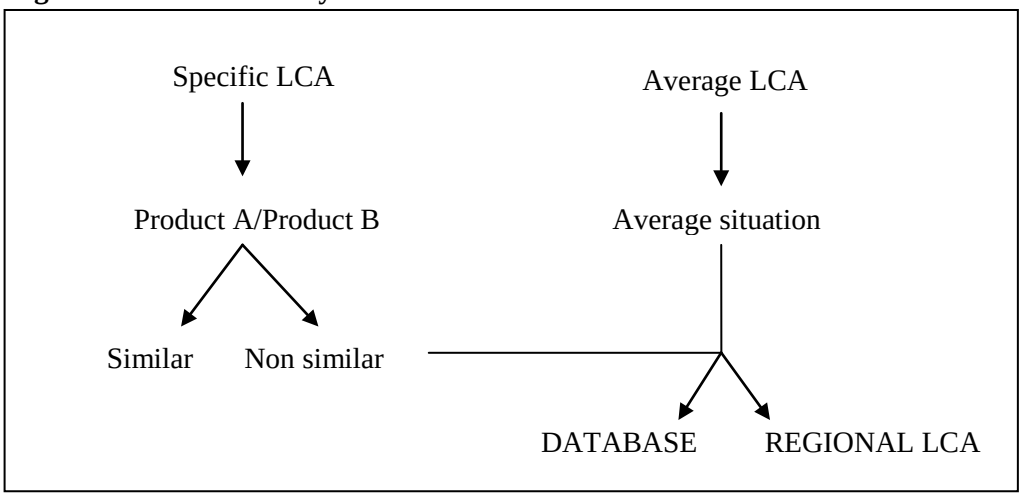
Nowadays, indeed, the environmental impacts related to a product and the possibility of quantifying the gap between them and a *benchmark* of the sector are becoming big issues. The importance of this question is proved by an exponential increase in the number of indeces used as measures of the gap from an average situation. Even companies and factories are raising their attention in this theme, with the result of an higher demand for *benchmarks* and *average datasets* in any sector of economy, in order to assess their environmental performances for self assessment, developing environmental reporting or implementing eco-labels.

Until today, one of the most asked question in the environmental assessment field focuses on the amount of carbon dioxide emitted on average by the production processes of a specific product. Furthermore, an high attention has been paid lately for the detection of geographic areas on Earth where the high-CO_2 productions are concentrated. Oppositely, the LCA methodology stands out thanks to its scientific feature of considering a variety of environmental impacts that cannot be considered nor assessed with a single-impact assessment method, as is a CO_2 calculator. Unfortunalely, this characteristic of LCA goes together with its applicative procedure, which is born to quantify the environmental impacts and make them unbiased and representative of a unique and established reality.

Hence, the aim of this study is trying to see, thanks also to the explanation of case studies, if it is possible to create an "*industry average LCA*", able of giving representing and unbiased and, at the same time, general and averaged information about all the companies belonging to the considered sector.

In the following picture the conceptual path of the study is shown:

Figure 1 Path of the study



Source: drawing up of the authors
Note: process followed in the research

1. The comparison between two products. “Similar” production systems.

Using an existing LCA on a product A to make considerations about another product B, there will never be a perfect 100% correspondence. The probability of finding a production system which is an exact copy of the first one is really low. This because, most likely, some variables are different in two production systems, as for example a technology used during a particular stage of the production process.

Obviously, lower is the correspondence rate on geographical, temporal and technological factors among the two considered systems A and B, lower will be the capacity of a LCA of the product A to consistently represent the product B. Differences among the geographical area and the temporal period in the production process on a same identical product X could result in smaller or bigger changes concerning: typologies and provenience of raw materials, country energy-mix, production technologies, transportations and waste management. The production processes of the same product, indeed, can be performed in a really different way depending on the country where it takes place. Furthermore, in the globalized society there are many “*globally produced products*”, products which life cycles cover several geographic areas during different step in the production chain. For the same reasons, also technological and temporal factors are relevant: in ten years, for example, there could be huge changes in the management methods of an industrial activity, or in the same period of time two Italian production systems could be disomogeneous because of the use of different machineries.

Obviously, the less the differences between the two products and productive, environmental and technological systems where they take place, the smaller would be the necessary arrangement work and, at the same time, the higher would be the capacity of the LCA of the product A to represent the product B. Hence the better way is to use the most similar product available LCA.

If it is considered that the pertinence of the information to be used in the Inventory Analysis of a LCA depends mainly on three factors, temporal geographical and technological, it could be stated that these are also the conditions to be respected to consider a production system similar to another.

In this way, the LCA of the whole productive system B is processed and handled in order to become unbiased representative of the system A. This method is faster and less work-intensive than developing a new complete LCA *ad hoc*, and at the same time provides good results with a medium/high rate of specificity and representativeness of the system A. Although, as explained, some requirements have to be respected.

2. “Non-similar” systems. *Regional* and *Global LCA* as rough studies.

If a user wants to take advantage of an existing LCA to make assumptions about another product and the two systems cannot be considered “similar”, or even in the case of constructing an *industry average LCA*, the path to be followed to build a consistent LCA study is divided in two different options:

1. Use *secondary data* from databases
2. Refer to a *Regional* or a *Global LCA*, which can give representative but rough information

2.1 Does the use of secondary data coming from databases make a company specific LCA unbiased and able to be representative even outside the original context?

Considering the more and more significant nature and role of databases in the elaboration of life cycle studies, it would be feasible trying the path of using in a LCA study exclusively this kind of secondary data.

Theoretically speaking indeed, a pure *Detailed LCA* of a specific productive site, exclusively based on *ad hoc* collected data, can never be representative outside its original context, because of its own nature strictly linked to the specific situation; in the same way a pure *Streamline LCA*, which is exclusively based on secondary data coming from databases, could be considered unbiased and sufficiently representative of a general system of the industrial sector under discussion, in the same geographic and temporal area (to which also the data from databases refer to). (Hochschorner and Finnveden, 2003).

The ones mentioned above are extremely strong and hasty examples, hardly feasible in practice; the first one due to the fact that it's extremely difficult to carry out and the second one due to the extreme degree of approximation in the analysis. Anyway it's still possible to make a few considerations.

First, a LCA in order to satisfy conditions and requirements stated by international organizations, first of all "*the best practices*" edited by ILCD (ILCD, 2010), has to be based on the highest possible number of *site specific data* and on an amount of *secondary average data* (databases, literature, previous studies, etc.) such that just plugs the gap of specific information and, in any case, for those processes and flows which do not have an high value according with the purpose of the analysis. In this way it is worth to underline that *primary data* have a big influence on final LCA results (Ross and Evans, 2002) and therefore, without any kind of manipulation, despite the equal nature of *secondary data* (either *unit process data* or *aggregated data*) the result would anyway be represented by two LCA studies, very different one from another. This is why it is possible to state, with reasonable confidence, that without a deep arrangement work, the LCA of the first product cannot be used to represent the second product.

This issue regarding the correct way of using information from databases, nevertheless, is gaining more and more importance even with reference to the chance of using *secondary data* belonging to a certain territory rather than generic data processed at international level. Nowadays, indeed, *secondary data* coming from main databases known in Italy do not refer to the national situation (Moresi, 2010) and for this reason, do not give justice to a "*exclusively Italian LCA*"; the only little exception regards those *globally produced products* that provide information helpful for many different situations.

The relevance of the topic has been emphasized by Rolf Frischknecht, member of the *Resources and Materials Commission of UNEP SETAC Life Cycle Initiative*, in a 2006 study (Frischknecht, 2006) who remarks how, in recent years, an increased number of projects has had the aim of creating National databases, as for instance happened in U.S.A, Japan, Germany and Switzerland, just to name a few cases. An exhaustive analysis lead the researcher to notice the existence of many points of discontinuity among the methods adopted for the construction of these databases, partly due to the development of LCA methodology in different geographic and cultural contexts (seldom interconnected or in communication among each other), partly to the different kinds of institutional organizations within the methodology grew up and got developed (companies, research departments, government bodies, etc.), and finally even to the amount of budget available.

Let's consider, for example, the cases of Japan and Switzerland. At a first sight they look very similar: both governments, aware of the huge capability of LCA methodology within the environmental policy promoted its progress. However they reveal huge differences as well, starting from the agencies involved: in Japan LCA program involved mainly firms and industries, while the push of a Swiss

database has to be referred mainly to the experiences of academic departments of research, advisory and governmental bodies.

Tab 1 The comparison between the goals stated for the development of National databases in Japan and Switzerland

Table 1: Comparison of the scope of the Japanese and the Swiss life cycle assessment initiatives; selected aspects

Aspect	Japan	Switzerland
LCA phases covered	LCI data, methodology and database as well as LCIA method developments (LIME, JEPIX)	Main focus on LCI data and database and the interface between current LCIA methods and the LCI database
elementary flows covered	LCI database limited to 14 air- and waterborne pollutants	Strive for an extension of quantified LCI parameters (e.g. land use, differenciation of size of particulate matters emitted)
product groups covered	Rather focused on major products and services (including consumer goods) delivered by Japanese industry	Rather focused and fairly complete on background data with a European scope (such as energy and material supply and transport and waste management services) but only very few consumer goods
Reference	(Narita N et al. 2003)	(Frischknecht et al. 2004)

Narita N, Nakahara Y, Morimoto M, Aoki R, Suda S (2003): The LCA Data Library – A Result of National LCA Project in Japan. In InLCA / LCM 2003, September 22–25, 2003. <www.lcacenter.org/InLCA-LCM03/Narita-presentation.pdf>, Seattle, Washington, USA
Öko-Institut (2005): Global Emission Model for Integrated Systems; GEMIS 4.2for <http://www.oeko.de/service/gemis/en/index.htm>, Darmstadt

Source: Frischknecht, Rolf, "Notions on the design and use of an ideal Regional or Global LCA Database", International Journal of LCA 11 (2006): 40-48
Note: some aspects of the comparison between Japanese and Swiss initiatives

2.1.1 The construction of an Italian database

In Italy, it is a long time researchers have been aware of the importance and need for the creation of an internal National database for LCA, able of supporting the hard work the scientific community have been doing in developing the methodology and making results more and more reliable and unbiased. Among the forces set down for this purpose stands the *Rete Italiana LCA*, which aim is making the methodology releasing by creating a network for information and knowledge exchange. In the actual context relying on *Life Cycle Analysis* and *Life Cycle Thinking* for public policies and companies competitiveness, it is important to set, here in Italy too, a sort of scientific authentication to all of these LCA studies (Cappellaro et al., 2008 and ENEA, 2011). Nowadays, the main obstacles of working in the LCA field in Italy concern the lack of available data on Italian systems and processes, and the necessity of adapting foreign characterization and assessment calculation methods (Eco-Indicator 99, EPS 2000, etc.), taking into consideration the main relevant impact categories in the environmental, social and cultural Italian context.

Thanks to these considerations, the Italian scientific community set a range of priorities: first of all the creation of an Italian database on waste management and treatments, but also on building ecodesign, on food processes, transportation, health care system, and the definition of an Italian assessment impact calculation method ("L'Analisi del Ciclo di Vita e la sua applicazione all'edilizia, alla gestione dei rifiuti, ai trasporti, ai prodotti agroalimentari e industriali, alle risorse e ai servizi").

However, the project of an Italian database is not a new idea; some of the work has been done in recent years. For example in 2000 the database I-LCA was born from an ANPA project with the aim of providing well representative data of Italian systems and processes for the *LCA Inventory Analysis*. This database contains the information of about 400 product processes, structured in four sectors: materials and processes, energy, transportation, end of life (Baldo and Pretato, 2001 and "Strumenti. Life Cycle Inventory LCD: I-LCA"). This project, however, is not considered very content-full and is based on

information typical of non-italian realities (Storchi A., "Prospettive di sviluppo del metodo LCA in Italia: il caso del Parmigiano-Reggiano").

Furthermore, the Regione Marche, ITACA (Istituto per la Trasparenza degli Appalti e la Compatibilità Ambientale), the ITC-CNR and the University Politecnico delle Marche in April 2008 subscribed a partnership for the cooperation with national and international professionals and experts with the goal of achieving a two-years project for the definition and development of the first Italian building materials and processes database, capable of combine physical-performance aspects with environmental features ("Banca dati dei materiali di riferimento per costruzioni ad elevata prestazione ambientale").

The *Carrello della spesa virtuale*, realized by WWF with the collaboration of S. Castaldi of the II University of Napoli and of R. Valentini and M. Moresi of the Tuscia University, can be considered a *Carbon Footprinting* study. In this project, many food products were assessed through LCA *ad hoc* performed with the use of the SimaPro 7.1.8 software; secondary data were used for the analysis of other products, for example *LCA FOOD DK* (http://www.lcafood.dk), *EcoInvent* and the 2008 *National Footprint* edition (the whole list of products and sources is available on the official website http://www.improntawwf.it/carrello/).

Even if not an Italian initiative, but considering the similarity between the two countries, it deserves to be stated the public project for the realization of a French database on agricultural products, AgryBALISE. This database has the aim of defining an appropriate dataset in relation with French realities, able to put the basis for the *environmental labeling* of food products and the environmental optimization of agricultural production systems (Van der Werf et al., 2010 and Koch et al., 2011).

All these efforts lay the foundation stone for the even more ambitious project of an Italian database able to provide to users all the necessary specific and always updated information.

2.2 "Regional LCA" and "Global LCA"

The issues detailed in previous paragraphs regarding the possibility of building a LCA based only on secondary data could change if it is considered as *industry averaged LCA*, instead of *company specific LCA*, which aim is to investigate the characteristics of an average industrial production in a specific geographic area. This particular study is what is mainly known as "*Regional LCA*" and, when it refers to the whole world, as "*Global LCA*".

This typology of LCA needs, as long as a *company specific LCA*, to be based mainly on primary data collected *ad hoc* in the considered production site, and is considered a "*best practice*" to use secondary data only in order to plug the gaps of data not available through direct collection, or for market informations, and always in the lowest possible quantity. Hence, to build a "*Regional LCA*", after the first steps of "*Goal and Scope Definition*", it is necessary a phase for primary data collection, which needs to be set down in an established number of companies in the geographic area x, previously stated to be a statistically significant sample for the analysis.

Subsequently, all these datasets need to be processed into *averaged datasets* through *vertical aggregation* and *horizontal averaging* methods (Baldo et al., 2008).

In particular, *vertical aggregation* is the method through which environmental data (input and output) regarding single processes, representing each step of the considered production system, linked among each other by intermediate flows (*unit processes*) are combined together. The result of this aggregation is a representation of the whole production system (*aggregated process dataset*) which input and output are equal to the addition of all the input and output of the single *unit process datasets*. As a

consequence, this elaboration allows to build up a set of aggregated information; this comes with the price of losing the high degree of representativeness of each process and link among processes.

On the other side, the *horizontal averaging* allows the user to elaborate different *unit processes* representing many possible ways of performing one step in the considered production chain, into an averaged process for that specific step of production (*aggregated process*). This is the procedure used for the creation of *average data* able to represent, in an established geographic and temporal context, a medium process of an exact step of an industrial production, as, for example, a country energy-mix or the background of raw materials used for plastic production in Europe (UNEP, 2011).

Hence, thanks to vertical and horizontal averaging the user is able to handle the collected *site-specific data* into *averaged data* (in other words, *unit process datasets* are elaborated into *aggregated datasets*) or, as an alternative, can choose for the study already elaborated *aggregated data*, extracting them from databases or from specific studies previously performed.

As we showed in previous paragraphs, *company specific LCA* results cannot be generalized and used for other realities, because they are strictly connected with the specific product, its context and the prerequisites set by authors of the study. Oppositely, if a *Regional LCA* is considered, it is allowed to deduct what follows: *Regional* and *Global LCA* are the LCA typologies which better suit the adjective "objective". Indeed, they are feasible of extrapolations and considerations in reference with a production system belonging to the economic sector considered in the LCA, with the only requirement that this system has to be inside the geographic area covered in the study; however, only general and medium considerations can be produced, loosing completely the capacity of the methodology of well representing specific characteristics and features of different realities.

3. The need to construct an Italian database and a Regional LCA: analysis of two case studies

The issues detailed in previous paragraphs appeared clear to the authors and the research group of the Prof. Beltramo Department, through the study and the analysis of two main research projects.

The first one, "*Green Economy Scenarios in the Mediterranean Region*" (GERME, Collegio Carlo Alberto research), deals with the study of the relationship between socioeconomic (supply/demand level and composition, water and energy consumption, pollutants emissions, demographic trends, environmental policies) and environmental dynamics (pollution, carbon dioxide concentration and climate change, water availability, etc.). In particular this connection has been investigated in Italy analyzing environmental impacts of food, transportations, commodities, etc., in relation with social changes and attitudes. The goal is to analyze each kind of product by the support of the LCA methodology, taking in consideration even other case studies and literature. The portion of the project under the *Dipartimento di Scienze Merceologiche* competence has the final objective of compiling a sort of database with the information regarding the environmental impacts of Italian items productions (enclosed in the ISTAT basket) obtained by LCA analysis, in order to support the development and running of an hybrid model, combining economic input–output analysis and environmental data (Rebitzer, 2004).

The second project, POLIEDRO, "*Pollenzo Index environmental and economics design*", proposed by the University of Scienze Gastronomiche (UNISG) in Pollenzo (Cuneo, Italy), aims to create a multidisciplinary index (Pollenzo Index) for the set up of a virtuous loop from agricultural and foods products sustainability in the territory. The idea is to aggregate different aspects (Gerbens-Leenes et al., 2003) to deepen the knowledge of culinary traditions of the interested region, the sociological aspects

that concern consumer as the last subject involved in the chain, the environmental aspects of product and packaging, and the economic convenience of labeling (Vesce and Pairotti, 2011). The portion of the project under the *Dipartimento di Scienze Merceologiche* competence deals with the construction and study of a methodology for calculation and environmental assessment of raw materials production and processing into final products.

Both projects, based on LCA studies, contributed to underline two main aspects:

- The necessity to arrange environmental average data for each productive sector and for each product
- The necessity to build an Italian dataset, as aggregation of many different *unit process dataset*

These two considerations are connected each other because the goal is to obtain a single dataset which contains Italian data representing the average situation of a sectorial process in the defined territory (Daalgard et al., 2004 and Nemeck and Erzinger, 2005). Data of a single region would be the best way to represent its distinctive features; these information indeed can constitute a good base for the methodology development in the country, even more if they represent the average situation (Finnveden et al., 2009).

3.1 The proposed hypothesys and methods

The goal of the GERME project is to construct an Italian database comprehensive of all the relevant information for the good LCA representation of all the Italian products enclosed in the ISTAT basket.

To realize that project it is necessary to:

- Apply the *vertical aggregation* method, in order to aggregate the different steps of a whole production cycle;
- Apply the *horizontal averaging* method, in order to build an *average data* from all the LCA studies of the statistical sample companies. This calculation needs to be performed for the same functional unit and taking into consideration the companies dimension (small, medium, large) and their geographic area (Nord of Italy, Centre, South).

Unfortunately until today, in Italy, no LCA studies have been performed through the *horizontal averaging* method, and it is not possible to find LCA studies for each food product typology enclosed in the basket (Moresi, 2010).

If there was the support of an Italian LCA database, the construction of a LCA completely based on secondary data would have been possible (it would not have been scientifically correct, but at least a representation at “regional” level).

Because of this lack of data and of appropriate Italian LCA studies, the *Dipartimento di Scienze Merceologiche* researches decided to use, together with the available Italian LCA results (as for example happened for the *Environmental Product Declaration* on pasta, performed by Barilla company), international and foreign information.

Oppositely, for the construction of the Pollenzo Index, the research group wrote down the environmental assessment procedure outline to be applied to all of those companies interested in getting the Index. A company can follow two different ways: the first one, called “C”, is the certificative one that includes a certification step by a third party organization; on the contrary, the second one is based on a self assessment only (called Non-Certificative, “NC”). The Index is structured in three levels, from lower to higher Bronze Silver and Gold, each one requiring companies to spend different amounts of effort for environmental analysis and calculations; the Gold one, for example, is the only one which requires the company to perform a complete LCA study. This tool represents the way to define in a objective and

unbiased way the terms for firms' behaviour comparison. The following scheme shows the main steps for the definition of the Gold level.

Tab 2 Outline procedure for Gold-level Certification

CERTIFICATION OUTLINE (Certificate organization)
Preparatory steps (Technical Committee) 1) Construction of LCA studies on different dimensions production systems of the considered economic sector, with the same functional unit and system boundaries. 2) Pick up of two main environmental aspects 3) Calculation of the average LCA (*Regional LCA*) and data (*benchmark*) for the chosen environmental aspects
Steps for the company 4) Building of a LCA study *ad hoc* for the company intended to get the label 5) Comparison between the environmental impacts of the company system with the *benchmark* defined by Technical Committee

Source: authors' analysis
Note: steps to follow to obtain the Gold-level certification

The work under the Technical Committee competence (steps 1, 2, 3) mainly consists on *horizontal averaging* for the individuation of the average production system datasets and its impacts (Strazza et al., 2010). The building of these average datasets begins, knowing all the companies working in the selected economic sector in the regional territory, with the identification of the representative companies (small, medium and large) and the elaboration of LCA studies for each one of them; the output of *horizontal average* operations on single companies datasets from these LCA studies is an average dataset able of representing the whole sector in the considered geographic area (*Regional LCA*).

Among all the environmental impacts and outputs concerning the average production system, the Technical Committee has to choose the two that are the most significant: they become the *benchmarks*, that are parameters for comparison with other companies.

The following steps (4, 5) are in charge of the company that intend to obtain the Index certification: to satisfy the requirements each firm has to carry out a LCA analysis and then compare itself with the average parameters, established by the Technical Committee.

Visibly, the main problem to the realization of this project is building the average production system for each economic sector, thanks to which it could be possible formulating environmental sustainability strategies for all the single companies voluntarily applying for the comparison between them and the *benchmark*.

This specific project includes only Piemonte geographic area, so that the process for the creation of the *Regional LCA* is really specific; furthermore, the aim is considering exclusively *gate-to-gate LCA* (limited to the production step of a product life cycle, and not including the background such as raw materials processing or waste management) so that there is no need of *vertical aggregation* operation. Essential is, oppositely, the use of the *horizontal average* method on an appropriate number of different dimensions production cycles, with the same functional unit, in order to take into consideration both big companies and craft businesses.

Still under these conditions, there wasn't a sufficient available number of companies LCA studies, so that a simplified procedure was implemented to make the project proceeding. This operation,

hopefully not able of results invalidation, consists on the definition of an "*averaged system*" and the calculation of its specific LCA; hence this simplified procedure differs from the original one because of the object of the *horizontal average* operation: here, indeed, instead of LCA studies results, the different production systems are averaged creating a *medium system*. From the results of the LCA on this *medium system* two main environmental impacts have to be chosen to be the comparison parameters with other companies LCA studies.

Conclusions

As detailed in previous paragraphs, the procedure of making an LCA study unbiased and representative even outside its original context is not often feasible in practice nor able of strengthen the LCA methodology as theoretically expected. Too many heavy obstacles, indeed, prevent to put this in practice. The environmental considerations about a product X cannot be based on a LCA study born and developed to represent another product Y, unless a deep arrangement work (often even not economically end temporally convenient) is stated, or an *industry average LCA* is used (as long as the high degree of approximation in the environmental considerations do not constitute a problem).

However, more and more requests of this kind are rising every day through the work on specific projects, so that often it is a one-way path in this direction; as long as the only alternative is giving up with the research, all the efforts are put into trying to preserve the scientifically consistency of the methodology.

Anyway, this issue does not mean that the LCA cannot be, in next future, a key element in facing the energetic and environmental inefficiency and problems. The international scientific community is walking through other roads which common aim is easing the development of *Life Cycle Science*, many of which are not discovered, yet.

First of all, it has been now stated the important role that the harmonization of international databases would play in increasing the comparability among LCA studies, exchange of information, easier data availability and international acknowledgment of information; all of these are fundamental requirements to make LCA the key element for next future scientific research.

Taking into consideration the raising in LCA uses for whole-sector assessment, constructing *Regional databases*, plugging gaps and smoothing out differences now existing among databases of different countries, are the next main challenges in LCA field.

References

- Guinée, B. Jeroen, Heijun Reinout, Huppes Gjalt, Zamagni Alessandra, Masoni Paolo, Buonamici Roberto, Ekvall Tomas and Rydberg Tomas, "Life cycle Assessment: past, present and future". Environmental Science & Technology, doi: 10.1021/es101316v 45 (2011): 90-96.
- Hochschorner, Elisabeth and Finnveden Göran, "Evaluation of two simplified Life Cycle Assessment methods". The International Journal of Life Cycle Assessment, 8, 3 (2003): 119-128, doi: http://dx.doi.org/10.1065/lca2003.04.114.
- European Union, Joint Research Centre, Institute for Environment and Sustainability, ILCD Handbook: General guide for Life Cycle Assessment - Detailed guidance, First edition 2010.

- Ross, Stuart and Evans David, “Excluding Site-Specific Data from LCA Inventory: how this affects life cycle impact assessment”. International Journal of Life Cycle Assessment, 3 (2002): 141-150.
- Moresi, Mario and Valentini Riccardo, “Dieta mediterranea e impatto ambientale”. Industrie alimentari, 49, 501(2010): 9-20.
- Frischknecht, Rolf, “Notions on the design and use of an ideal Regional or Global LCA Database”. International Journal of Life Cycle Assessment 11 (2006): 40-48, doi: http://dx.doi.org/10.1065/lca2006.04.010.
- Cappellaro, Francesca, Scalbi Simona and Masoni Paolo, “The Italian network on LCA”. International Journal of Life Cycle Assessment, 13 (2008): 523-525, doi 10.1007/s11367-008-0041-9.
- ENEA, La Rete Italiana LCA: prospettive e sviluppi del Life Cycle Assessment in Italia, a cura di Francesca Cappellaro e Simona Scalbi, 2011.
- “L’Analisi del Ciclo di Vita (LCA) e la sua applicazione all’edilizia, alla gestione dei rifiuti, ai trasporti, ai prodotti (agroalimentari e industriali), alle risorse e ai servizi”, accessed March 19, 2012, http://www.provincia.fe.it/download/neri.pdf?server=sd2.provincia.fe.it&db=/intranet/internet.nsf&uid=324B5DB1E5D1C628C1257507002A5A0C.
- Baldo, Gianluca and Pretato Ugo, “A Database to Support Italian LCA Practitioners”, International Journal of Life Cycle Assessment, 6, 3 (2001): 180.
- “Strumenti. Life Cycle Inventory (LCD): I-LCA”, accessed March 26, 2012, http://www.lens-italia.polimi.it/s_ilca.htm
- Storchi, Andrea, “Prospettive di sviluppo del metodo LCA in Italia: il caso del Parmigiano-Reggiano”, 2004, http://digilander.libero.it/giabon/tesi/storchi/storchi.htm
- “Banca dati dei materiali di riferimento per costruzioni ad elevata prestazione ambientale”, accessed March 26, 2012, http://www.ecomake.it/2011/PROGRAMMA/17febbraio/S.Catalino.pdf
- Van der Werf, Hayo M.G., Gaillard Gérard, Biard Yannick, Koch Peter, Basset-Mens Claudine, Gac Armelle, Lellahi Afsameh and Deltour L., “Creation of a public LCA database of French agricultural raw products: agriBALYSE”. Paper presented at the VIIth International Conference on Life Cycle Asessment in the agri-food sector, Bari, September 22-24, 2010.
- Koch, Peter, Gaillard Gérard, Van der Werf Hayo M.G., Biard Yannick, Basset-Mens Claudine, Gac Armelle, Lellahi Afsameh and Paillier Anne, “Methodological guidelines for LCA of French agricultural products”. Paper presented at the LCM 2011 - Towards Life Cycle Sustainability Management, Berlin, August, 28-31, 2012.
- Baldo, Gianluca, Marino Massimo and Rossi Stefano, Analisi del ciclo di vita LCA. Gli strumenti per la progettazione sostenibile di materiali, prodotti e processi, Edizioni Ambiente, 2008.
- United Nations Environment Programme, Guidance Principles for Life Cycle Assessment Databases-A Basis for Greener Processes and Products, 2011.
- Rebitzer, Gerald, Ekvall Tomas, Frischknecht Rolf, Hunkeler David, Norris Gregory, Rydberg Tomas, Schmidt J-P., Suh Sangwon, Weidema Bo P. and Pennington David W., “Life cycle assessment. Part 1: Framework, goal, scope definition, inventory analysis and application”. Environmental International, 30, 5 (2004): 701-720, http://dx.doi.org/10.1016/j.envint.2003.11.005

- Gerbens-Leenes, P. Winnie, Moll Henri C. and Schoot Uiterkamp A. J. M., “Design and development of a measuring method for environmental sustainability in food production systems”. Ecological Economics, 46 (2003): 231-248, doi.org/10.1016/S0921-8009(03)00140-X
- Vesce, Enrica and Pairotti M. Beatrice, “Una proposta per la costruzione di un indice multidisciplinare per la valorizzazione dei prodotti agroalimentari: il progetto Poliedro e la parte ambientale”. Paper presented at the XXV Meeting of Commodities Sciences, Trieste, September 26 – 28, 2011.
- Daalgard, Randi, Halberg Niels, Kristensen I. Sillebak and Larsen Inger, “An LC Inventory based on representative and coherent farm types”, 98-106. Paper presented at the 4th International Conference, October 6-8, 2003, Bygholm, Denmark, in: Halberg N. (Ed.), Life Cycle Assessment in the Agri-food sector, DIAS Report, Animal Husbandry, 61, October 2004.
- Nemecek, Thomas and Erzinger Stefan, “Modelling representative Life Cycle Inventories for Swiss Arable Crops”. International Journal of Life Cycle Assessment, 10, 1, (2005): 1-9, doi: http://dx.doi.org/10.1065/lca2004.09.181.8.
- Finnveden, Göran, Hauschild Michael Z., Ekvall Tomas, Guinée Jeroen, Heijun Reinout, Hellweg Stefanie, Koehelr Annette, Pennington David and Suh Sangwon, “Recent developments in Life Cycle Assessment”. Journal of Environmental Management, 91 (2009): 1-21, doi.org/10.1016/j.jenvman.2009.06.018.
- Strazza, C., Del Borghi A., Blengini G. and Gallo A., “Definition of the methodology for a Sector EPD (Environmental Product Declaration): case study of the average Italian cement”. International Journal of Life Cycle Assessment, 15 (2008): 540-548, 10.1007/s11367-010-0198-x.